REMARKS

I.   Introduction

By the present Amendment, claims 1 and 26 have been amended. No claims have been added or cancelled. Accordingly, claims 1-6 and 26-29 remain pending in the application. Claims 1 and 26 are independent.

II.   Office Action Summary

In the Office Action of July 29, 2009, claims 1-6 were rejected under 35 USC §101 as failing to fall within one of the four statutory categories of invention. Claims 1, 4, 5, 26, and 27 were rejected under 35 USC §102(b) as being anticipated by Ko et al. ("Ko"). Claim 2 was rejected under 35 USC §103(a) as being unpatentable over Ko in view of Henry et al. ("Henry"). Claim 3 was rejected under 35 USC §103(a) as being unpatentable over Ko in view of U.S. Patent number 6,801,650 issued to Kikuchi et al. ("Kikuchi"). Claims 6, 28, and 29 were rejected under 35 USC §103(a) as being unpatentable over Ko in view of Xu et al. ("Xu"). These rejections are respectfully traversed.

III.   Rejections under 35 USC §101

Claims 1-6 were rejected under 35 USC §101 as failing to fall within one of the four statutory categories of invention. Regarding this rejection, the Office Action indicates that the claims appear to recite a series of steps or tasks to be performed, but they do not transform an article nor are they positively tied to a particular machine that accomplishes the claimed method steps. Therefore, they do not qualify as a statutory process. The Office Action further indicates that the claims do not positively recite any structures which tie them to a statutory category, and that there

is no indication that the data represents a physical object or substance which would allow it to be modified by the process in a meaningful manner.

By the present amendment, Applicants have amended independent claim 1 to better define the claimed method with respect to the statutory classes of invention. Applicants have directly tied several steps to a particular machine or apparatus. For example, the claim has been amended so that it defines a method of classifying defects using a defect review apparatus. The image of the defect is now indicated as being obtained using either an electron type image detector or an optical image detector. Additionally, the characteristic of the defect obtained from the image is extracted using a characteristic extractor.

Applicants further submit that the claimed data does, in fact, represent a physical object or substance. Specifically, the claims relate to identification and classification of defects on a sample such as a semiconductor electronic circuit board, a printed circuit board, a liquid crystal display board, etc. As can be appreciated, various defects can appear on the sample as a result of the manufacturing or fabrication process. By properly identifying and classifying the different types of defects, it is possible to determine which processing step (or steps) is responsible for the defect. Accordingly, the processing step can be evaluated and/or modified in order to minimize the number of defects, thereby improving yield and decreasing costs.

Based on the foregoing, it is respectfully submitted that claims 1-6 now fall into one of the four statutory categories of invention. Withdrawal of this rejection is therefore respectfully requested.

IV. Rejections under 35 USC §102

Claims 1, 4, 5, 26, and 27 were rejected under 35 USC §102(b) as being anticipated by Ko. Regarding this rejection, the Office Action indicates that Ko discloses a method for classifying defects that includes obtaining an image of a defect on a sample, extracting a characteristic of the defect from the image, and classifying the defect according to a rule based classification and learning type classification. The Office Action goes on to indicate that the step of classifying also includes calculating a first set of likelihoods using a rule-based classification, calculating a set of second likelihoods using extracted characteristics, calculating a third set of likelihoods by using the first and second likelihoods, and classifying the defect using the third likelihoods. Additionally, the rule-based classification and learning type classification are indicated as being present in a parallel relationship with each other and independent of each other. Applicants respectfully disagree.

As amended, independent claim 1 defines a method of classifying defects using a defect review apparatus. The method comprises:

> obtaining an image of a defect on a sample using one of an electron type image detector and an optical image detector;

> extracting a characteristic of the defect from the image using a characteristic extractor; and

> classifying the defect in accordance with the extracted characteristic, and based on a rule-based classification and a learning type classification,

> wherein the step of classifying further comprises:

> calculating a set of first likelihoods of the defect belonging to each of a plurality of defect classes of the rule-based classification, by use of the extracted characteristic using a likelihood function;

> calculating a set of second likelihoods of the defect belonging to each of a plurality of defect classes of the learning type classification, by use of the extracted characteristic;

calculating a third set of likelihoods of the defect belonging to each of the defect classes of the learning type classification and/or the defect classes of the rule-based classification, by use of the first and second likelihoods; and

classifying the defect by use of the third likelihoods; and

wherein the rule-based classification and learning type classification are present in a parallel relationship with each other and independent of each other.

According to the method of independent claim 1, an image of a defect on a sample is first obtained using either an electron type image detector or an optical image detector, and a characteristic of the defect is extracted from the image using a characteristic extractor. Next, the defect is classified in accordance with the extracted characteristic, and based on a rule-based classification and a learning type classification. The classification step also includes several substeps. Specifically, a set of first likelihoods that the defect belongs to each of the plurality of defect classes of the rule-based classification is calculated using the extracted characteristic and using a likelihood function. Next, a set of second likelihoods is calculated that the defect belongs to each of a plurality of defect classes of the learning type classification using the extracted values. A set of third likelihoods of the defect belonging to each of the defect classes of the learning type classification and/or the defect classes of the rule-based classification is calculated using the first and second likelihoods. The defect is then classified using the third likelihoods. Furthermore, according to independent claim 1, the rule-based classification and learning type classification are present in a parallel relationship and are also independent of each other.

Contrary to the assertions made in the Office Action, Ko differs from the claimed invention. Furthermore, Applicants disagree with the contention that the

LVQ neural network is "inherently rule-based since no classification algorithm can operate or execute without rule-based." Ko discloses an adaptive learning mechanism and a supervised learning method. Both of these, however, are learning type classifiers, and they differ from rule-based classifiers. In an attempt to clarify the differences between these two types of classifiers, Applicants are enclosing two documents that describe the differences between these two methodologies:

1) Jiawai Han, Micheline Kamber, "Second Edition Data Mining Concepts and Techniques", pp.318-321, Morgan Kaufmann (2006); and

2) Simone Marinai, Hiromichi Fujisawa, "Machine Learning in Document Analysis and Recognition", pp.139-140, Spring (2008).

These documents are being provided to support the fact that rule-based classifications and learning type classifications (such as neural networks) are treated differently in the art As disclosed in the document by Jiawai Han, rule-based classifications use a set of "if-then" rules. The "if" portion is described as the criteria for classification, and executed explicitly upon a true result. Furthermore, learning type routines using a sample are not executed.

In contrast, the criterion for classification in a learning type classification is determined by using a sample, as explained in the document of Simone Marinai. Various methods are suggested for determining the classification criteria, including neural networks, support vector machines, and ensemble methods. Based on the foregoing, the contention of an LVQ neural network being inherently rule-based would appear to be incorrect.

In order to distinguish features of the present invention for Ko, independent claim 1 has been amended to explicitly recite the use of a likelihood function when

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classifying the defects based on the rule-based classification. As can be appreciated, likelihood functions are not used in learning type classification methods, such as those disclosed by Ko. Additionally, Ko appears to be completely silent on the use of a likelihood function, particularly with respect to calculation of the first likelihoods of the defects belonging to the defect classes of the rule-based classification. Ko also necessarily fails to disclose the two types of classifications in a parallel relationship with each other. Specifically, there is no disclosure for features recited in independent claim 1, such as:

> classifying the defect in accordance with the extracted characteristic, and based on a rule-based classification and a learning type classification,
>> wherein the step of classifying further comprises:
>>> calculating a set of first likelihoods of the defect belonging to each of a plurality of defect classes of the rule-based classification, by use of the extracted characteristic using a likelihood function;
>
>> ...
>
> wherein the rule-based classification and learning type classification are present in a parallel relationship with each other and independent of each other.

It is therefore respectfully submitted that independent claim 1 is allowable over the art of record.

Claims 2-6 depend from independent claim 1, and are therefore believed allowable for at least the reasons set forth above with respect to independent claim 1. In addition, these claims each introduce novel elements that independently render them patentable over the art of record.

As amended, independent claim 26 defines an apparatus for classifying defects that comprises:

an imager which obtains an image of a defect on a sample;

a characteristic extractor which extracts a characteristic of the defect from the image;

a classifier which classifies the defect in accordance with the extracted characteristic, and based on a rule-based classification and a learning type classification, and

a display for displaying the image of the defect and the classification result on a screen;

wherein said classifying means comprises:

a rule-based classifier which calculates a set of first likelihoods of the defect belonging to each of plurality of rule classes by use of the characteristics of the defect using a likelihood function,

a learning type classifier which calculates a set of second likelihoods of the defect belonging to each of a plurality of defect classes by use of the characteristic of the defect; and

a calculator which calculates a set of third likelihoods of the defect belonging to each of said defect classes and/or rule classes, by use of the first and second likelihoods, and

a classifier which classifies the defects by use of the calculated third likelihoods; and

wherein the rule-based classification and learning type classification are present in a parallel relationship with each other and independent of each other.

Independent claim 26 has been amended in a manner similar to independent claim 1. In particular, this claim now recites the use of a likelihood function by the rule-based classifier which calculates a set of first likelihoods of the defect belonging to each of a plurality of rule classes based on the characteristics of the defect. Additionally, the rule-based classification and learning type classification are provided in a parallel relationship, and independent of each other. As previously discussed with respect to independent claim 1, Ko only discloses learning type classifications and, consequently, fails do provide any disclosure or suggestion for the claimed features.

It is therefore respectfully submitted that independent claim 26 is allowable over the art of record.

Claims 27-29 depend from independent claim 26, and are therefore believed allowable for at least the reasons set forth above with respect to independent claim 26. In addition, these claims each introduce novel elements that independently render them patentable over the art of record.

V. Rejections under 35 USC §103

Claims 2, 3, 6, 28, and 29 were rejected under 35 USC §103(a) as being unpatentable over Ko in view of various secondary references. As previously indicated, however, Ko fails to disclose or suggest various features that are now recited in independent claims 1 and 26, from which these claims began. Applicants' review of these secondary references has also failed to reveal any disclosure or suggestion for the same features. Accordingly, these combinations of references still fail to render the claimed invention obvious.

It is therefore respectfully submitted that these references are further allowable over the art of record.

VI. Conclusion

For the reasons stated above, it is respectfully submitted that all of the pending claims are now in condition for allowance. Therefore, the issuance of a Notice of Allowance is believed in order, and courteously solicited.

If the Examiner believes that there are any matters which can be resolved by way of either a personal or telephone interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

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AUTHORIZATION

Applicants request any shortage or excess in fees in connection with the filing

of this paper, including extension of time fees, and for which no other form of

payment is offered, be charged or credited to Deposit Account No. 01-2135 (Case:

500.43701X00).

Respectfully submitted,

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Dated: November 30, 2009

Attachments: Two (2) reference documents